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U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

Attorney's Docket Number: **0675-30**

**TRANSMITTAL LETTER TO THE UNITED STATES  
DESIGNATED/ELECTED OFFICE (DO/EO/US)  
CONCERNING A FILING UNDER 35 U.S.C. 371**

U.S. APPLICATION NO. (If known, see 37 CFR 15)

**09/601319**INTERNATIONAL APPLICATION NO.  
**PCT/JP98/01673**INTERNATIONAL FILING DATE  
**April 10, 1998**PRIORITY DATE CLAIMED  
**February 6, 1998**

TITLE OF INVENTION

**ELECTROMAGNETIC ACTUATOR AND MOUNTING STRUCTURE**

APPLICANT(S) FOR DO/EO/US

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Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(I).
4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☐ A copy of the International Application as filed (35U.S.C. 371(c)(2))
  - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
  - b. ☐ has been transmitted by the International Bureau.
  - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (a35 u.s.c. 371(c)(3)).
  - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
  - b. ☐ have been transmitted by the International Bureau.
  - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
  - d. ☐ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

**ITEMS 11. to 16. below concern other document(s) or information included:**

11. ☐ An Information Disclosure Statement under 35 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☐ A FIRST preliminary amendment.  
☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information:  
 Copy of PCT Publication WO99/39843  
 Seven (7) Sheets of Formal Drawings

U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.55)

09/601319

INTERNATIONAL APPLICATION NO.  
PCT/JP98/01673

ATTORNEY'S DOCKET NUMBER: 0675-30

17. ☒ The following fees are submitted:**Basic National Fee (37 CFR 1.492(a)(1)-(5)):**

Search Report has been prepared by the EPO or JPO ..... \$ 840.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) ..... \$ 670.00

\* No international preliminary examination fee paid to USPTO (37 CFR 1.482)

but international search fee paid to USPTO (37 CFR 1.445(a)(2)) ..... \$ 760.00

Neither international preliminary examination fee (37 CFR 1.482) nor

international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... \$ 970.00

International preliminary examination fee paid to USPTO (37 CFR 1.482)

and all claims satisfied provisions of PCT Article 33 (2)-(4) ..... \$ 96.00

**CALCULATIONS [PTO USE ONLY]****ENTER APPROPRIATE BASIC FEE AMOUNT =**

\$840.00

Surcharge of \$130.00 for furnishing the oath or declaration later than ☐ 20 ☒ 30  
months from the earliest claimed priority date (37 CFR 1.492(e)).

\$130.00

Claims	Number filed	Number Extra	Rate		
Total Claims	16 - 20 =	0	X \$18.00	\$	
Independent Claims	8 - 3 =	5	X \$78.00	\$390.00	
Multiple dependent claim(s) (if applicable)			+ \$260.00	\$	
<b>TOTAL OF ABOVE CALCULATIONS =</b>				\$1,360.00	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed. (NOTE 37 CFR 1.9, 1.27, 1.28).				\$	
<b>SUBTOTAL =</b>				\$1,360.00	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$	
<b>TOTAL NATIONAL FEE =</b>				\$1,360.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property				+	\$
<b>TOTAL FEES ENCLOSED =</b>				\$1,360.00	
				Amount to be refunded	\$
				charged	\$

a. ☒ A check in the amount of \$1,360.00 to cover the above fee is enclosed.b. ☐ Please charge my Deposit Account No. \_\_\_\_\_ in the amount of \$ \_\_\_\_\_ to cover the above fees.  
A duplicate of this sheet is enclosed.c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 19-2380. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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JHV/rmg/sas

7/PRB

09/601319

526 Rec'd PGT/PTO 07 AUG 2000

## ELECTROMAGNETIC ACTUATOR AND MOUNTING STRUCTURE

### 5 FIELD OF TECHNOLOGY TO WHICH INVENTION BELONGS

This invention concerns an electromagnetic actuator and a structure for mounting it in portable electronic equipment such as a pager or portable telephone, as a means of notification of a call by means of a buzzer, audio tone or vibration  
10 when a signal is received.

### BACKGROUND OF INVENTION

Pagers and portable telephones are made with built-in notification devices, which have vibrators as well as buzzers, as a means of call notification in  
15 conferences and other locations where it is inappropriate to use an audible alarm. If the vibration mode is switched on in advance, the vibrator is driven instead of an alarm being sounded when a call comes in, and the recipient is made aware of the call by means of the vibration.

20 In the past, this vibration has been created by a small motor, an eccentric weight attached to the shaft of the motor such that a vibration it generated when the battery-driven motor is caused to rotate.

As portable electronic equipment including pagers and portable telephones has become smaller and lighter, further miniaturization of motors has become  
25 necessary, but there are limits to the miniaturization of call notification devices with both vibrators and buzzers. Moreover, because the amount of vibration from battery drive is fixed, there is a further drawback in that there are individual differences in the strength of vibration necessary.

To resolve this problem, the applicants have developed a speaker-type  
30 electromagnetic actuator that does not use the small motor of U.S. patent no.

5,528,697.

This electromagnetic actuator is an epochal product that combines the function of selecting the vibration ring, buzzer ring or tone ring as a vibration mode into the same unit as the speaker function. It is so constituted that when a given frequency is impressed on a coil, the interaction of the magnetic field of the magnets and the current impressed on the coil generates vibration in a vibration plate in the case of a low frequency or a resonant tone in a diaphragm in the case of a high frequency. Moreover, because it is possible to control the amount of vibration and the frequency, the amount of vibration can be adjusted and set at the level desired by the individual.

As portable telephone equipment has become widely used, there has been demand for an electromagnetic actuator that can suppress the external leakage of magnetic flux and also have good frequency characteristics even though small in size. There has also been demand for high durability within the usage environment of portable electronic equipment with internal electromagnetic actuators, such that they do not break even if the user drops them. There is further demand, from the perspective of cost reduction, for reduction of the number of parts and for ease of assembly.

## OVERVIEW OF INVENTION

This invention is an improved electromagnetic actuator with a small and simple structure, having a coil on which current is impressed, a magnet that forms a magnetic circuit between its poles across a magnetic gap with a magnet yoke, and having a diaphragm that vibrates when a high-frequency current is impressed, and a vibration plate that vibrates when a low-frequency current is impressed, with the coil placed within the magnetic gap and the parts enclosed within a basket. The structure for mounting the electromagnetic actuator is also improved.

One purpose of this invention is to suppress the external leakage of magnetic flux. To achieve this purpose, this invention can be constituted with a radial array

of magnets, a vibration plate with a double-suspension structure, and a bottom plate of magnetic shielding material placed in the basket.

Another purpose of this invention is to constitute the electromagnetic actuator with good frequency characteristics even when it is small. To achieve that purpose, this invention selects the material of the vibration plate and also uses the basket as a third vibrator, in addition to the diaphragm and the vibration plate.

A further purpose of this invention is to constitute an electromagnetic actuator with high impact resistance. To achieve this purpose, the invention is constituted with a elastic material that retains and supports the vibration plate within the basket.

This invention also has the purpose of cost-reduction, and is constituted with a diaphragm that holds the coil in a raised portion, and a vibration plate that holds both the magnets and the magnet yoke on its surface.

In addition, this invention has the purpose of further improving frequency characteristics and impact resistance by means of the mounting structure for the electromagnetic actuator. Thus this invention is constituted with elastic packing sandwiched between the basket of the electromagnetic actuator and the housing case of the portable electronic equipment, and also between the basket of the electromagnetic actuator and the mounting structure.

#### BRIEF EXPLANATION OF DRAWINGS

Figure 1 is a cross section showing the assembly structure of the electromagnetic actuator of this invention.

Figure 2 is an exploded oblique drawing of the first vibrator, which is a structural part of the electromagnetic actuator of this invention.

Figure 3 is an exploded oblique drawing of the second vibrator, which is a structural part of the electromagnetic actuator of this invention.

Figure 4 is an exploded oblique drawing of the basket, which is a structural part of the electromagnetic actuator of this invention.

Figure 5 is an explanatory drawing showing the order of assembly of the electromagnetic actuator of this invention.

Figure 6 is an explanatory drawing showing a partial cross section of the equipment case and mounting substrate as the mounting structure of the electromagnetic actuator of this invention.

Figure 7 is an oblique drawing showing the elastic packing used in the mounting structure of the electromagnetic actuator of figure 6.

Figure 8 is a graph showing the frequency characteristics of the mounting structure of the electromagnetic actuator without the elastic packing of figure 7.

Figure 8 is a graph showing the frequency characteristics of the mounting structure of the electromagnetic actuator with the elastic packing of figure 7.

#### DETAILED EXPLANATION

To explain this invention in detail with reference to the drawings, the electromagnetic actuator of this invention is constituted, as shown in figure 1, with a first vibrator 1 that produces a resonant tone when a high frequency current is impressed, a second vibrator 2 that produces a vibration when a low frequency current is impressed, and a basket 3 that contains the first and second vibrators 1, 2 as the minimum necessary assembly parts.

The first vibrator 1 comprises, as shown in figure 2, a voice coil (hereafter simply "coil") 10 that is wound in a circular shape and on which either a high frequency or low frequency current can be impressed, and a thin diaphragm 11 that holds the coil 10 in place.

The diaphragm 11 is formed from a thin disk of a polymer material such as polyether imide (PEI). This diaphragm 11 has a concentric circular projection 11a that projects to a given height from the surface to hold the coil 10 in place. The surface of the diaphragm 11 also has a concentric circular lip 11d near the outer edge that divides the vibrating portion 11b from the outer rim 11c that is necessary for assembly with the basket 3. The coil 10 is fixed to the projection 11a on the surface

of the diaphragm 11, and is thus held in place by the diaphragm 11.

Because of the structure of the first vibrator 1, no other support member is needed to hold the coil 10 in place, and so it is possible to reduce the number of parts and also to mount the coil 10 easily. Moreover, because the coil 10 is fixed to the projection 11a that projects from the surface of the vibrating portion 11a [sic, should be 11b], it is possible for this vibrating portion 11b to maintain good frequency characteristics, unaffected by having the coil 10 mounted.

The second vibrator 2 comprises, as shown in figure 3, a magnet 20 that forms a magnetic circuit, a magnet yoke 21 that holds the magnet 20 in place, and a thin vibrator plate 22 that holds the magnet yoke 21 in place.

The magnet 20 is shaped for a radial array. The magnet 20 of this radial array forms a ring with its north and south poles on the inner and outer peripheries to produce a magnetic circuit radiating between poles. The magnet 20 is held within the magnet yoke 21 and forms a unit with the magnet yoke 21 such that the north and south poles are positioned parallel to the first vibrator 1 and second vibrator 2. The magnet 20 is divided into four or some other number of pieces to facilitate placement in the magnet yoke 21.

The magnet yoke 21 is saucer shaped, with an outer rim 21a, and a raised pole piece 21b in the center. This pole piece 21b is a raised portio with a diameter smaller than the inner periphery of the magnet 20, so as to interpose a magnetic gap G (see figure 1) in the inner periphery of the magnet 20.

The vibration plate 22 is punched from a sheet of springy metal, and has a springy structure with a center plate 22a that is fixed to the magnet yoke 21, an outer rim 22b that can be fixed to the basket 3, and multiple curved arms 22c that connect the center plate and the outer rim.

Because the second vibrator 2 has the radially arrayed magnet 20, it is possible to suppress the leakage of magnetic flux in the direction of vibration of the diaphragm 11 and vibration plate 22 that vibrate through the attraction and repulsion by the magnetic force of the magnet 20 and the magnetic force generated by the coil 10. As with the constitution of the first vibrator 1, there is no need for a separate

support member to support the magnet yoke 21, and so it is possible to reduce the number of parts and to assemble the magnet 20 and the magnet yoke 21 easily.

Now, to assure space for the coil 10 to enter to the back of the magnetic gap G in the magnet yoke 21, the yoke is assembled with a spacer 24 between it and the magnet 20.

The second vibrator 2 has, in addition to the vibration plate 22 described above, another vibration plate 23 with a center plate 23a, an outer rim 23b that can be fixed to the basket 3, and multiple curved arms 23c that connect the center plate and the outer rim. The center hole 23d of the vibration plate 23 has a diameter larger than the outer periphery of the coil 11 [sic] so that the coil 10 can be placed within the magnetic gap G.

Because the second vibrator 2 has two vibration plates 23 [sic] that form a double-suspension structure, the magnetic shielding is further enhanced and it is possible to suppress the leakage of magnetic flux even more effectively. And because it improves the vibration resistance, it is possible to maintain the initial vibration characteristics.

The vibration plates 22, 23 can be made of any stainless steel or alloy of copper and titanium that does not require an aging/hardening process after being punched. In order to improve the hardness/Young's modulus of the spring parts of vibration plates of these materials, it is possible to increase the resonant frequency to produce a large amount of vibration. Now, multiple notches 22d, 23e are made at regular intervals in the outer rims 22b, 23b in order to fix these vibration plates 22, 23 inside the basket 3.

As shown in figure 4, the basket 3 is formed as a low round housing that comprises a basket body 30 that accommodates the first and second vibrators 1, 2, a cover plate 31 that covers the upper side of the basket body 30, and a thin, flat bottom plate 32 that covers the bottom side of the basket body 30.

The basket body 30 is a round frame made of a polymer material such as polybutylene terephthalate (PBT) [corrected from "polyether imide (PEI)"]. Its inner surface has steps 30a to receive the outer rim 11c of the diaphragm 11, as well



as the cover plate 31. The lower side of the steps 30 [sic] projections 30b (only one is shown in figure 4) that engage the notches 22d, 23e of the vibration plates 22, 23. The basket body 30 also has air holes 30c in its side, and on the upper edge there is a cutout 30d for the flexi substrate that makes the electrical connection with the coil 10. The cover plate 31 is disk-shaped, and has a number of sound holes 31a, 31b . . . This cover plate 31 can be made of a metal with magnetic properties so as to function as a magnetic shield.

The bottom plate 32 is a part of the basket 3, and is formed of a polymer-- polyethylene terephthalate (PET), polyether imide (PEI) or polyimide (PI)-- so as to function as a thin vibration plate. It is best formed with a thickness not less than 50  $\mu\text{m}$  and not greater than 100  $\mu\text{m}$ .

When this bottom plate 32 is provided, it becomes a third vibrator of the electromagnetic actuator, and improves the frequency characteristics, including those of the first vibrator 1 and the second vibrator 2. Moreover, it is good to have at least one concentric lip 32a and or 32b on its surface; the lips 32a, 32b can improve efficiently the frequency characteristics of the bottom plate 32.

Within the basket 3 there is an elastic piece 33 formed of a rubber-based elastomer. This elastic piece 33 comprises a cylindrical outer wall 33a that fits against the inside of the basket body 30, and a protrusion 33b that projects inward from the outer wall 33a. The protrusion 33b of the elastic piece 33 can be continuous around the inner circumference, or it can be divided into three or four sections. In the upper edge of the elastic piece 33 there are notches 33c that fit the projections 30b [labelled 33b in figure 4] of the basket body 30.

Aside from this elastic piece 33, the basket 3 has a spacer ring 34 to assure vibration space between the vibration plate 22 of the second vibrator 2 and the bottom plate 32 of the basket 3.

Of the parts of the basket 3, as shown in figure 1, the outer rim 22b of the vibration plate 22 is sandwiched between the elastic piece 33 and the spacer ring 34. In this way, the second vibrator 2 is supported, and the upper surface of the outer rim 23b of the vibration plate 23 is held down against the step 30b of the basket body 30.

By providing this elastic piece 33 within the basket 3, it is possible to buffer the impact force, in the event that the user drops the portable electronic equipment in which the electromagnetic actuator is mounted, by directing it from the second vibrator 2 into the elastic piece 33. Moreover, because the protrusion 33b is in contact with the outer edge of the magnet yoke 11 [sic], if the second vibrator 2 is shaken sideways on impact, the protrusion 33b acts as a stopper against the outer edge of the magnet yoke 11 [sic], thus preventing distortion of the vibration plates 23, 23. Therefore, it is possible to provide great impact resistance such that the electromagnetic actuator is not broken.

To assemble the actuator from the various parts described above, the basket body 30 is taken as the base and the diaphragm 11 with the coil 10 attached, and then the cover plate 31 are fit in to the steps 30a through the top of the basket body 30. The terminals of the coil 10 are kept long enough to allow the vibration of the diaphragm 11, and are connected electrically to the flexi substrate 4 that projects outward from the outer rim of the diaphragm 11.

From the under side of the basket body 30, on the other hand, the upper vibration plate 23 of the second vibrator 2 is inserted with the projections 30b of the basket body 30 aligned with the notches 23e. In the same way, the elastic piece 33 is inserted into the basket body 30 with the projections 30b of the basket body 30 aligned with the notches 30d, and assembled so that the outer rim 23b of the upper vibration plate 2 [sic] of the second vibrator 2 is supported. Next, the magnet yoke 21 that supports the spacer 24 and the magnet 20 is attached to the surface of the lower vibration plate 22, and the lower vibration plate 22 is inserted into the basket body 30. A spacer ring 34 that presses the outer rim 22b of the lower vibration plate 22 against the elastic piece 33 is inserted, and then the bottom plate 32 is fit into the lower opening of the basket body 30.

In the assembled actuator, the first vibrator 1 and the second vibrator 2 are facing as shown in figure 1, and the coil 10, suspended through the central opening 23d of the upper vibration plate 23, is in position to be attracted and repulsed upward and downward within the magnetic gap G between the inner circumference

of the magnet 20 and the pole piece 21b of the magnet yoke 21.

In this electromagnetic actuator, when the designated frequency is impressed on the coil 10, the electromagnetic action between the magnetic field of the magnet 20 and the current impressed on the coil 10 causes a vibration to be generated by the vibration plates 22, 23 at a low frequency, or a resonant tone to be generated by the vibration of the diaphragm at a high frequency. And because it is possible to control the amount of vibration and the frequency, the amount of vibration can be adjusted to the individual preference.

When this electromagnetic actuator is mounted in portable electronic equipment, the electromagnetic actuator is normally fixed in place within the equipment case by positioning it so as to cover the sound holes in the equipment case, with a ring of elastic packing sandwiched between the equipment case and the basket of the electromagnetic actuator.

The structure for attachment of the electromagnetic actuator of this invention is, as shown in figure 6, to position it over the sound holes E so that a ring-shaped elastic packing 5 is sandwiched between the inside surface of the equipment case C and the basket 3 of the electromagnetic actuator A. At the same time, the elastic packing 7 is held between the basket 3 of the electromagnetic actuator A and the surface of the mounting substrate 6 that accommodates the electromagnetic actuator A within the equipment case C.

These elastic packings 5, 7 can be made of a polymer material such as urethane foam. Of these, the elastic packing 7 that is placed against the surface of the mounting substrate 6 comprises a cylindrical outer wall 7a and an elastic base 7b that extends inward from the outer wall 7a, as shown in figure 7.

This elastic packing 7 is prepared as a part of the electromagnetic actuator A by fitting the outer wall 7a to the lower circumference of the basket body 30 as shown in figure 6, with the elastic base 7b against the surface of the mounting substrate 6 and sported by multiple stops 6a, 6b located on the mounting substrate 6. In this way, the elastic base 7b is in place between the surface of the mounting substrate 6 and the basket 3 of the electromagnetic actuator A, and the

electromagnetic actuator A is accommodated within the equipment case C.

Now, at the bottom of the electromagnetic actuator A there is, as shown in figure 6, an opening 6c in the mounting substrate 6. And as shown in figure 7, there can be notches 7c [labelled 8c in the drawing] in the elastic base 7b that go through the outer wall 7a to provide air passages.

Regarding the effect of this structure for mounting the electromagnetic actuator, compared with the frequency shown in figure 8 for the electromagnetic actuator mount without elastic backing, figure 9 shows that better stability is available in frequency characteristics in the range from 800 Hz to 3 KHz, and so this structure is capable of improving frequency characteristics even though it is a small and simple structure.

The words and expressions used above in the particulars of this invention were chosen simply for the purpose of explanation, and do not limit the content of the invention in any way. In the event that limiting words or expressions have been used, that is not intended to exclude equivalent modes of this invention or parts thereof. It is clear, therefore, that it is possible to make various changes to the scope of this invention for which rights are claimed.

WHAT IS CLAIMED IS:

1. An electromagnetic actuator having a coil on which current is impressed, a magnet that forms a magnetic circuit between its poles across a magnetic gap with a magnet yoke, a diaphragm that vibrates by magnetic action when a high-frequency current is impressed and a vibration plate that vibrates by magnetic action when a low-frequency current is impressed, with the coil positioned within the magnetic gap and the parts thereof being accommodated in a basket, in which the magnet is radially arrayed and positioned with its north and south poles parallel to the diaphragm and the vibration plate.

2. An electromagnetic actuator as described in claim 1 above, in which there are two vibration plates with the magnet between them, the two vibration plates providing a double-suspension structure.

3. An electromagnetic actuator as described in claim 1 or 2 above, in which the cover of the basket is used as magnetic shielding.

4. An electromagnetic actuator having a coil on which current is impressed, a magnet that forms a magnetic circuit between its poles across a magnetic gap with a magnet yoke, a diaphragm that vibrates by magnetic action when a high-frequency current is impressed and a vibration plate that vibrates by magnetic action when a low-frequency current is impressed, with the coil positioned within the magnetic gap and the parts thereof being accommodated in a basket, in which the vibration plates are made of a stainless steel or alloy of copper and titanium that does not require an aging/hardening process after being formed.

5. An electromagnetic actuator having a coil on which current is impressed, a magnet that forms a magnetic circuit between its poles across a magnetic gap with a magnet yoke, a diaphragm that vibrates by magnetic action

when a high-frequency current is impressed and a vibration plate that vibrates by magnetic action when a low-frequency current is impressed, with the coil positioned within the magnetic gap and the parts thereof being accommodated in a basket, in which the basket has a thin bottom plate that also serves as a vibration plate.

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6. An electromagnetic actuator as described in claim 5 above, in which the basket has a thin bottom plate with at least one lip that is concentric with the plate.

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7. An electromagnetic actuator as described in claim 5 or 6 above, in which the basket has a thin bottom plate formed of a material chosen from among polyethylene terephthalate (PET), polyethyl imide (PEI) or polyimide (PI).

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8. An electromagnetic actuator having a coil on which current is impressed, a magnet that forms a magnetic circuit between its poles across a magnetic gap with a magnet yoke, a diaphragm that vibrates by magnetic action when a high-frequency current is impressed and a vibration plate that vibrates by magnetic action when a low-frequency current is impressed, with the coil positioned within the magnetic gap and the parts thereof being accommodated in a basket, in which the vibration plate is supported within the basket by an elastic piece that presses against the surface of the outer rim of the vibration plate.

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9. An electromagnetic actuator as described in claim 8 above, in which the magnet yoke is supported by the vibration plate and the elastic piece has an inward protrusion that is positioned close to the outer edge of the magnet yoke.

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10. An electromagnetic actuator having a coil on which current is impressed, a magnet that forms a magnetic circuit between its poles across a magnetic gap with a magnet yoke, a diaphragm that vibrates by magnetic action when a high-frequency current is impressed and a vibration plate that vibrates by

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magnetic action when a low-frequency current is impressed, with the coil positioned within the magnetic gap and the parts thereof being accommodated in a basket, in which the coil is supported by a concentric projection that projects from the surface of the vibrating portion, and there is a diaphragm within the basket.

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11. An electromagnetic actuator having a coil on which current is impressed, a magnet that forms a magnetic circuit between its poles across a magnetic gap with a magnet yoke, a diaphragm that vibrates by magnetic action when a high-frequency current is impressed and a vibration plate that vibrates by magnetic action when a low-frequency current is impressed, with the coil positioned within the magnetic gap and the parts thereof being accommodated in a basket, in which the coil is supported by a concentric projection that projects from the diaphragm, and the coil and diaphragm are assembled in a single unit.

12. An electromagnetic actuator having a coil on which current is impressed, a magnet that forms a magnetic circuit between its poles across a magnetic gap with a magnet yoke, a diaphragm that vibrates by magnetic action when a high-frequency current is impressed and a vibration plate that vibrates by magnetic action when a low-frequency current is impressed, with the coil positioned within the magnetic gap and the parts thereof being accommodated in a basket, in which the magnet is held in a magnet yoke and the magnet yoke holding the magnet is supported by the surface of the vibration plate, and the magnet, magnet yoke and vibration plate are assembled in a single unit.

13. An electromagnetic actuator mounting structure for mounting an electromagnetic actuator inside portable electronic equipment in which elastic packing is sandwiched between the inner surface of the equipment case and the basket of the electromagnetic actuator and between the basket of the electromagnetic actuator and the electromagnetic actuator mounting substrate, so that the electromagnetic actuator is mounted inside the portable electronic equipment.

14. An electromagnetic actuator mounting structure as described in claim 13 above, in which the elastic packing is fitted to the bottom of the basket, and is sandwiched between the basket of the electromagnetic actuator and the mounting substrate.



## ABSTRACT OF THE DISCLOSURE

An improved electromagnetic actuator having a coil (10) on which a current is impressed, a magnet (20) that forms a magnetic circuit across a magnetic gap (G) with a magnet yoke (21), and having a diaphragm (11) that vibrates when a high-frequency current is impressed, and a vibration plate (22) that vibrates when a low-frequency current is impressed, with these parts enclosed within a basket (3) and the coil (10) placed within the magnetic gap (G). As one invention, a radial array of magnets, a vibration plate with a double-suspension structure, and a bottom plate of magnetic shielding material are placed in the basket to suppress the leakage of magnetic flux. As an invention to further improve the frequency characteristics by means of the mounting structure of the electromagnetic actuator, elastic packing (5, 7) is sandwiched between the basket of the electromagnetic actuator and the housing case of the portable electronic equipment, and also between the basket of the electromagnetic actuator and the mounting.



FIGURE 3

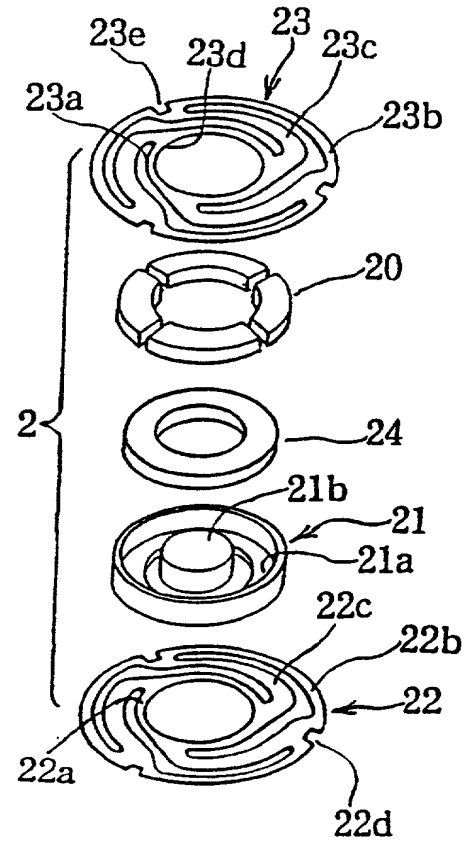


FIGURE 4

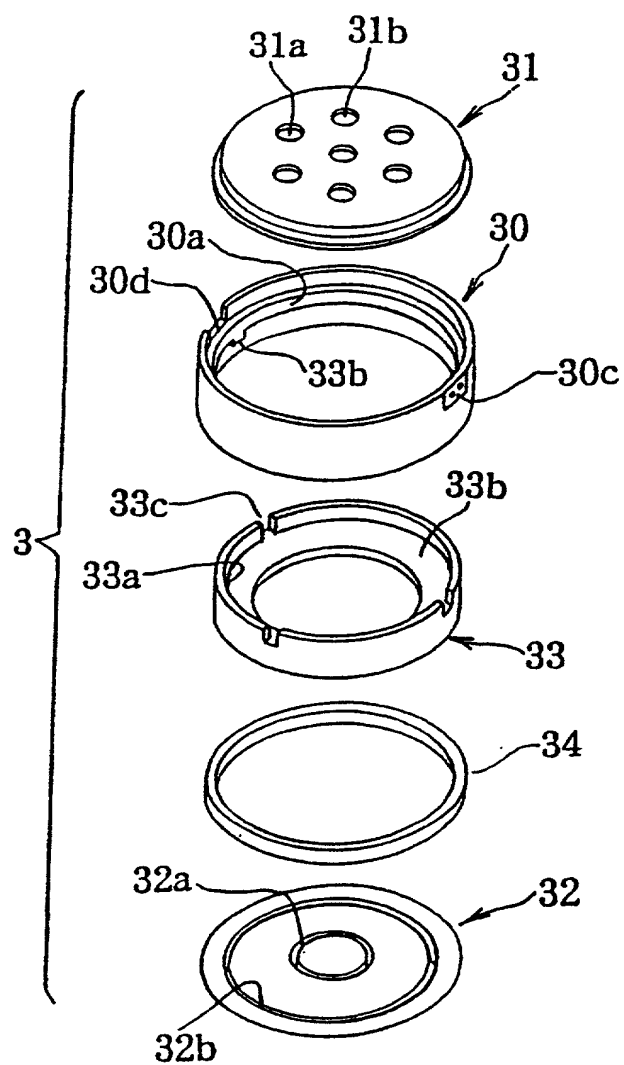


FIGURE 5

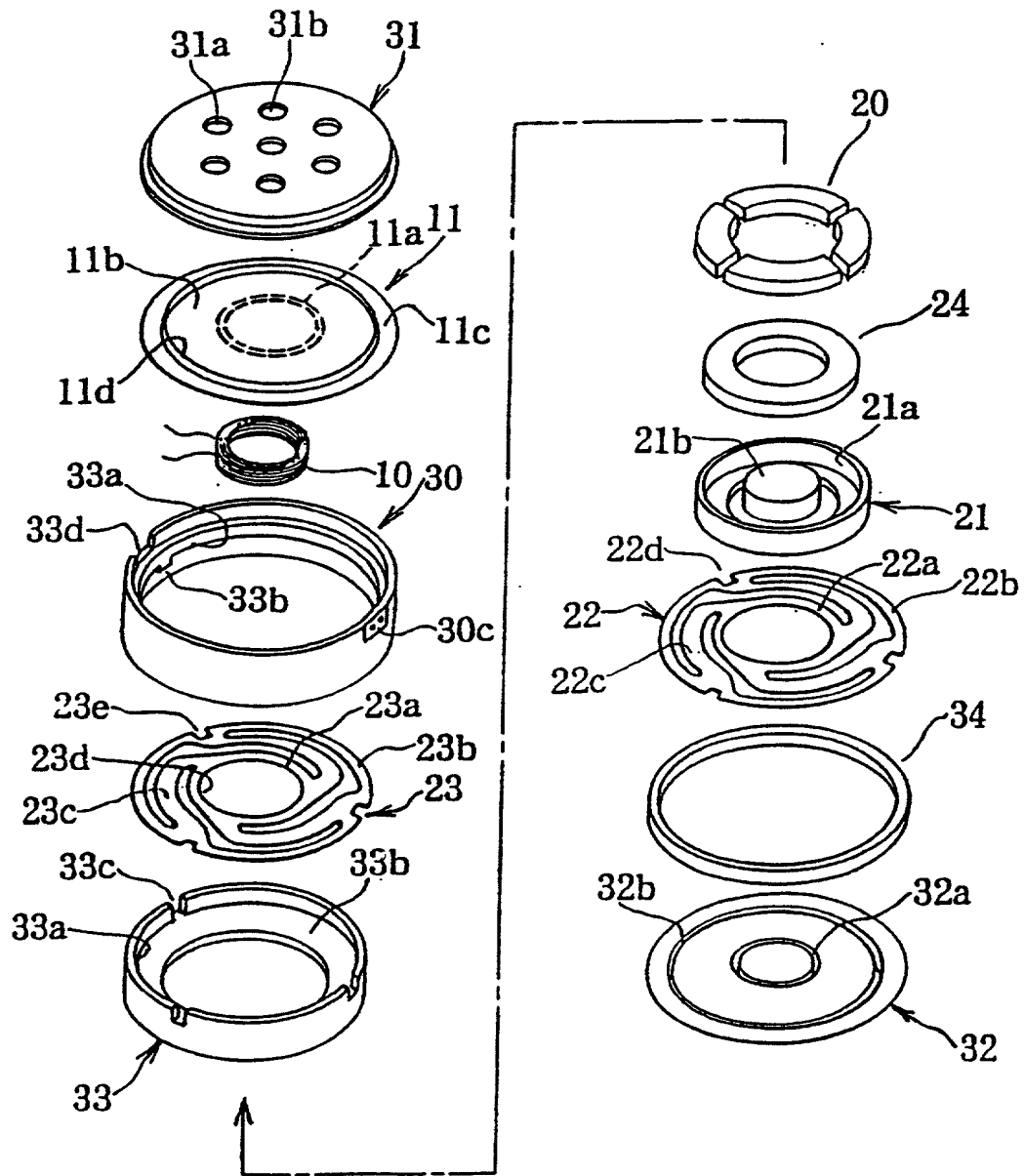


FIGURE 6

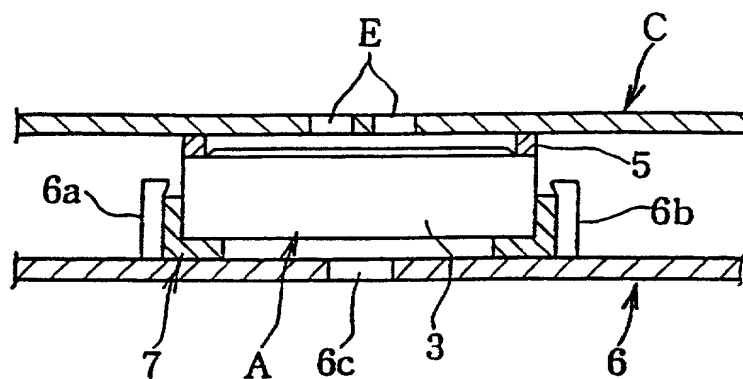


FIGURE 7

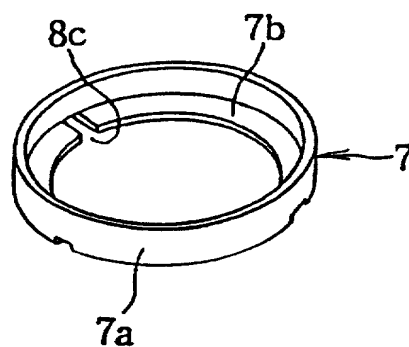


FIGURE 8

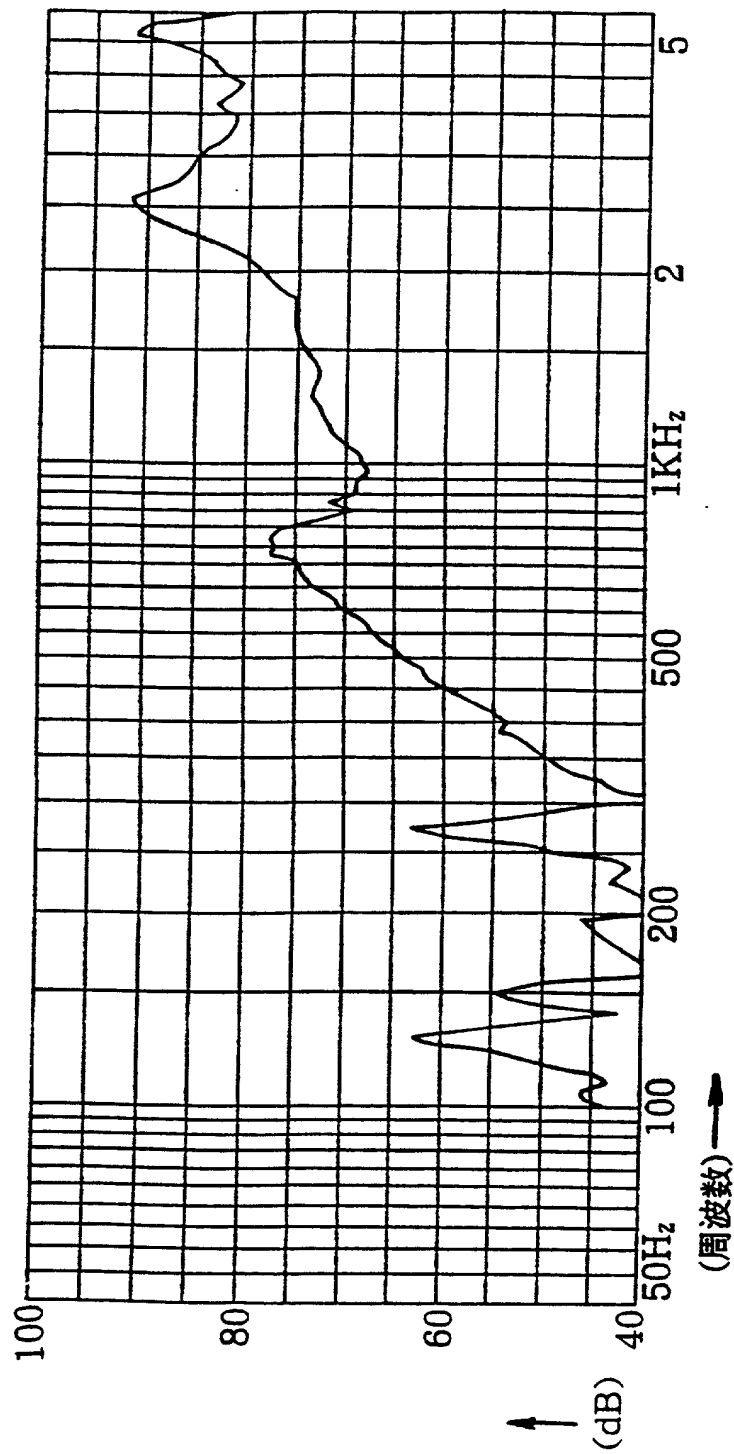
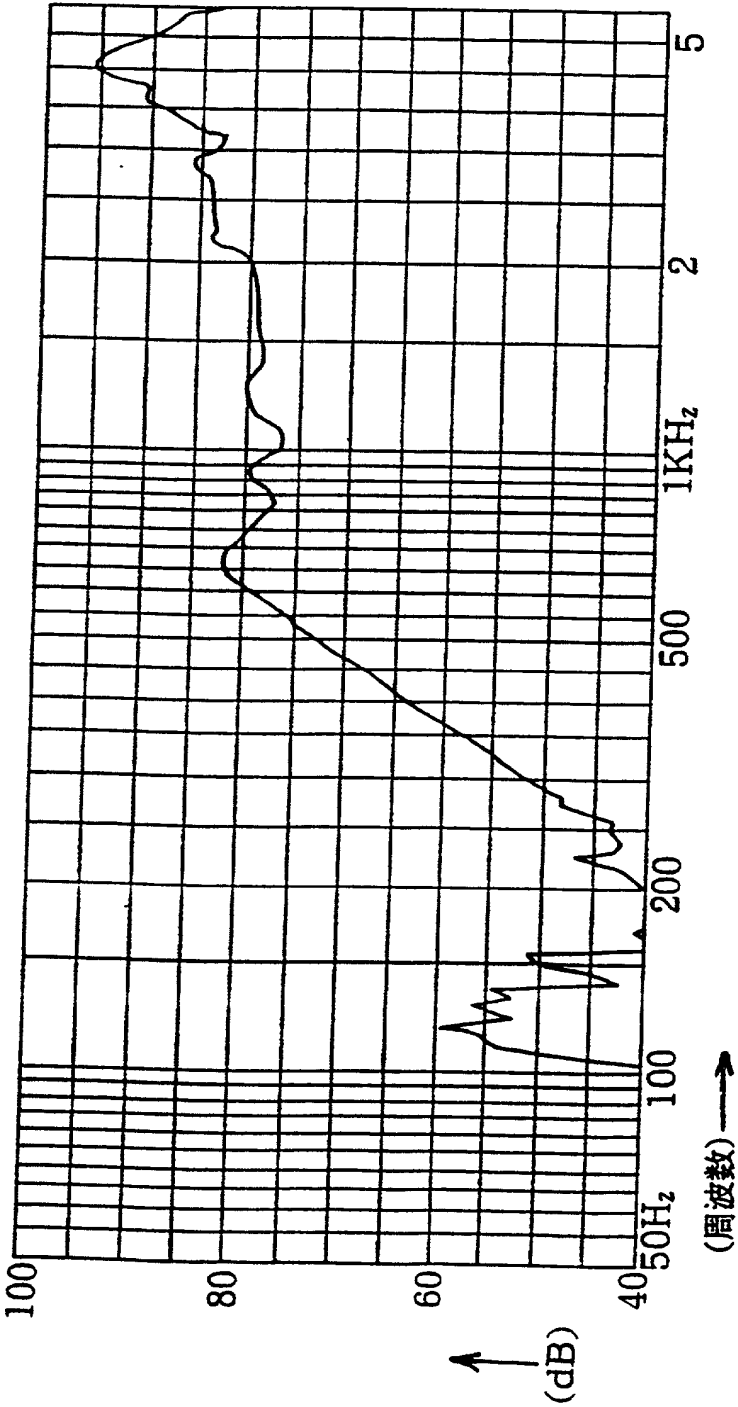


FIGURE 9





**DECLARATION FOR  
UTILITY OR DESIGN  
PATENT APPLICATION  
(37 CFR 1.63)**

☐ Declaration Submitted With Initial Filing      OR      ☒ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	0675-30
First Named Inventor	Tsunco Kyouno et al.
<b>COMPLETE IF KNOWN</b>	
Application Number	09/601,319
Filing Date	August 7, 2000
Group Art Unit	
Examiner Name	

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

ELECTROMAGNETIC ACTUATOR AND MOUNTING STRUCTURE  
(Title of the invention)

the specification of which

☐ is attached hereto  
OR

☒ was filed on (MM/DD/YYYY) August 7, 2000 As United States Application Number or PCT International Application Number PCT/JP98/01672 And was amended on (MM/DD/YYYY) \_\_\_\_\_ (If applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached	
				YES	NO
10/41183	Japan	February 6, 1998	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
10/82489	Japan	March 13, 1998	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)	<input type="checkbox"/> Additional provisional application Numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

[Page 1 of 2]

**Burden Hour Statement:** This form is estimated to take 0.4 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioners for Patents, Washington, DC 20231.

## DECLARATION - Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(a) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority date sheet PTO/SB/02B attached hereto.

As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: ☒ Customer Number 22204

OR

☒ Registered practitioner(s) name/registration number listed below.

Name	Registration Number	Name	Registration Number
Daniel W. Shboy	20,932	Tim L. Brackley, Jr.	36,092
Seamus J. Friedman	24,312	Eric J. Robinson	31,285
Charles M. Leedom, Jr.	26,477	Robert M. Schmalzer	31,196
Gerald J. Ferguson, Jr.	23,016	Daniel S. Song	43,143
David S. Saffan	27,997	Marc S. Kaufman	35,212
Thomas W. Cole	28,290	Corinne A. Gorski	34,339
Donald R. Studebaker	32,815	James E. Howard	39,715
Jeffrey L. Cornella	35,463	Kenneth G. Salen	43,077
Brian C. Oakes	41,667		
Jason H. Vick	45,285		

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that without false statements and the like no made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor:

☐ A petition has been filed for this unsigned inventor.

Given Name (first and middle (if any))

Family Name or Surname

**Tsunao KYOUNO**

Inventor's Signature:

*Tsunao Kyouno*

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Citizenship: Japanese

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City: Tokyo

State:

ZIP: 123-8511

Country: JAPAN

☒ Additional inventors are being named on the 2nd Supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto.

Please type a plus sign (+) inside this box → [ + ]

PTO/SB/02A (3-97)  
Approved for use through 9/30/98. OMB 0651-0032  
Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

DECLARATION		ADDITIONAL INVENTOR(S) Supplemental Sheet Page <u>3</u> Of <u>3</u>	
Name of Additional Joint Inventor, if any:		<input type="checkbox"/> A petition has been filed for this unsigned inventor.	
Given Name (first and middle) [if any]		Family Name or Surname	
Teruo YOSHINARI			
Inventor's Signature: <i>Teruo Yoshinari</i>		Date: <i>20.10.2000</i>	
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Post Office Address c/o Namiki Precision Jewel Co., Ltd., 8-22 Shinden 3-Chome, Adachi-ku			
City: Tokyo <i>202</i> State:		ZIP: 123-8511 Country: JAPAN	
Name of Additional Joint Inventor, if any:		<input type="checkbox"/> A petition has been filed for this unsigned inventor.	
Given Name (first and middle) [if any]		Family Name or Surname	
Minoru UEDA			
Inventor's Signature: <i>Minoru Ueda</i>		Date: <i>20.10.2000</i>	
Residence: City: Tokyo State:		Country: Japan Citizenship: Japanese	
Post Office Address c/o Namiki Precision Jewel Co., Ltd., 8-22 Shinden 3-Chome, Adachi-ku			
City: Tokyo <i>202</i> State:		ZIP: 123-8511 Country: JAPAN	
Name of Additional Joint Inventor, if any:		<input type="checkbox"/> A petition has been filed for this unsigned inventor.	
Given Name (first and middle) [if any]		Family Name or Surname	
Inventor's Signature:		Date:	
Residence: City:		State: Country: Citizenship:	
Post Office Address			
City:		State: ZIP: Country:	

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